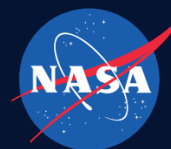


Lighting Automation â Flying an Earthlike Habitat Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)



ABSTRACT

Our proposal will enable the development of automated spacecraft habitats for long duration missions. Majority of spacecraft lighting systems employ lamps or zone specific switches and dimmers. Automation is not in the “picture”. If we are to build long duration environments, which provide earth-like habitats, minimize crew time, and optimize spacecraft power reserves, innovation in lighting automation is a must. To transform how spacecraft lighting environments are automated, we will provide performance data on a standard lighting communication protocol. We will investigate utilization and application of an industry accepted lighting control protocol, DMX512. We will demonstrate how lighting automation can conserve power, assist with lighting countermeasures, and utilize spatial body tracking. By using DMX512 we will prove the “wheel” does not need to be reinvented in terms of smart lighting and future spacecraft can use a standard lighting protocol to produce an effective, optimized and potentially earthlike habitat.

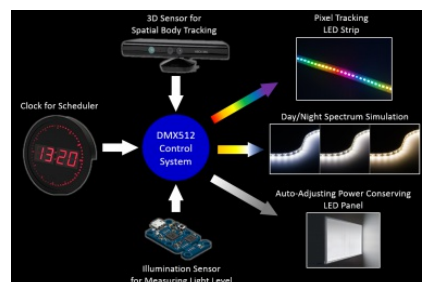
ANTICIPATED BENEFITS

To NASA funded missions:

This technology will benefit all human rated spacecraft and the humans that have to live within that spacecraft by providing a user friendly, energy efficient, time saving, and healthy habitat that by design can seamlessly interface with flight avionics software while using hardware architectures that are COTS compatible, further reducing development costs.

DETAILED DESCRIPTION

Currently, spacecraft lighting systems are not demonstrating innovations in automation due to perceived costs in designing circuitry for the communication and automation of lights. With



This diagram provides a high level workflow describing the lighting controls goals of this project.

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Management Team

Program Director:

- Jay Falker

Program Executive:

- Ricky Howard

Program Manager:

- Christopher Culbert

Project Manager:

- Toni Anne Clark

Principal Investigator:

- Toni Anne Clark

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advances in solid state lighting, the potential to enhance a spacecraft habitat is lost if the communication and automation problem is not tackled. DMX512 is an internationally governed, industry-accepted, lighting communication protocol with wide industry support. The lighting industry markets a wealth of hardware and software that utilizes DMX512, and there may be incentive to space certify the system. To demonstrate the smart lighting capabilities of DMX512, we will build an automated lighting control rig with three demos. We will showcase how such a system can be used for automated power conservation, closed loop countermeasures, and assistance using spatial body tracking. We hope our demonstrations will inspire other NASA engineers, architects and researchers to consider employing DMX512 "smart lighting" capabilities into their work.

To assess DMX512 features and capabilities for real time lighting control automation, we will use a lighting control rig partially built with funding from 2016's Innovation Charge Account. The existing rig has eight large luminous LED light panels, which are DMX512 compatible. We plan to supplement the lighting rig with a long strip of individual LEDs, each LED programmable and color tunable using the DMX512 protocol. The light hardware will be controlled using a Madrix™ Plexus controller. Also, we will integrate a timer, an illumination sensor, and a Kinect® 3D sensor with the DMX512 controller to enable smart lighting and showcase three operational demos. The entire lighting system will be controlled by in-house developed software using C/C++ DMX512 API.

The deliverable is a DMX512 lighting control rig and three smart lighting demos. (1) The lighting system will monitor the illumination on a surface and provide real time control input to LED light panels to maintain a constant illumination level, thus balancing outside light with LED light panel illumination and enabling smart power conservation. (2) The system will command individual LEDs of a light strip to track a user moving

Technology Areas

Primary Technology Area:

Human Exploration Destination Systems (TA 7)

Secondary Technology Area:

Human Health, Life Support, and Habitation Systems (TA 6)

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along a line of path, to demonstrate lighting spatial body tracking. (3) We will simulate an enforced lighting schedule, a 24-hour sunlight cycle that enforces the Circadian rhythm.

We will pursue future opportunities with IR&D, NASA HRP grants, and investigate implementation in habitation design efforts such as Cis-Lunar Gateway and Habitable Airlock. Focus will be set on human integration and hardware/software flight certification issues in implementing DMX512 for future spacecraft. We will use our test-bed to demonstrate how the DMX512 lighting protocol could be integrated with spacecraft avionics platforms to enable smart lighting capabilities.

PROJECT RESULT SUMMARY:

Circadian Lighting Countermeasure

A Red-Green-Blue-White (RGBW) Pixel LED strip was used to generate a multi-spectrum light output. Utilizing Madrix® a lighting control application, a set of colors that represented warm, neutral, and cool white light was put into a timed function. The software interpolated the dimming intensity ranges for each color channel such that the apparent "color" of the white light has the proper gradient from one color of white to the next over a range of times. For demonstrations purposes, the simulation provides an accelerated representation of a 24 hour circadian lighting countermeasure.

Illumination Maintenance (Steady State Light Levels)

The simulation utilized a set of signal channel LED light panels with Pulse Width Modulated dimming provided by a DMX512 decoder. The lighting control system utilized a Madrix® lighting control application, scripts, and real time USB illuminance light sensor data, and C++ coding. An open loop control algorithm provided direction for increasing or decreasing lighting intensity until the light sensor data fell within a threshold.

Follow the Leader

To advance the concept of occupancy sensors and lighting where it is only needed, a simulation was developed that made a group of LEDs on a LED pixel strip follow the movement of a hand waving near the light strip. The simulation used a Kinect® camera, a RGBW LED pixel strip, a RGBW pixel LED strip, a DMX512 compatible pixel decoder, a DMX controller, C++, scripts, and a Madrix® lighting control application. The simulation successfully demonstrated the use of 3D position monitoring devices to control the state of a light with respect to that lamp's location in 3D space.

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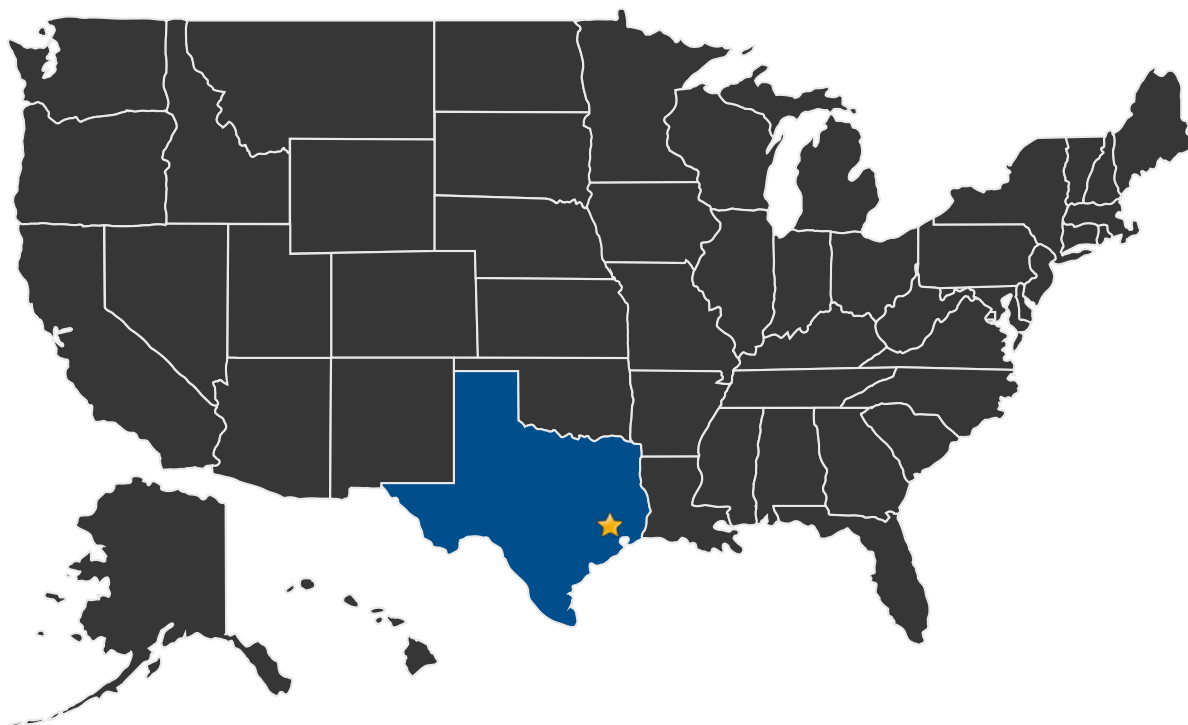
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DETAILED PROJECT REPORT

A detailed project report can be found in the Tech Port project library for "Lighting Automation - Flying an Earthlike Habitat".

U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work

★ **Lead Center:**
Johnson Space Center

Other Organizations Performing Work:

- Leidos, Inc.
- MEI Technologies

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PROJECT LIBRARY

Final Reports

- Lighting Automation- Flying an Earthlike Habitat
 - (<https://techport.nasa.gov:443/file/28079>)

IMAGE GALLERY



Image Credit: Lighting Environment Test Facility

Lighting Control Simulation

Foreground: "Follow the leader" gesture control

Background: "Illumination maintenance" control

This image shows a linear LED Pixel Light System dynamically responding to user input. A sensor has detected the position of the user's hand and causes a group of LEDs to turn red and follow the position of the user's hand.

DETAILS FOR TECHNOLOGY 1

Technology Description

This technology is categorized as an architecture for manned spaceflight

Capabilities Provided

Autonomous Environmental Habitat - In Situ Utilization

Currently, spacecraft lighting systems are not demonstrating innovations in automation due to

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perceived costs in designing circuitry for the communication and automation of lights. With advances in solid state lighting, the potential to enhance a spacecraft habitat is lost if the communication and automation problem is not tackled. DMX512 is an internationally governed, industry-accepted, lighting communication protocol with wide industry support. The lighting industry markets a wealth of hardware and software that utilizes DMX512, and there may be incentive to space certify the system. To demonstrate the smart lighting capabilities of DMX512, we will build an automated lighting control rig with three demos. We will showcase how such a system can be used for automated power conservation, closed loop countermeasures, and assistance using spatial body tracking. We hope our demonstrations will inspire other NASA engineers, architects and researchers to consider employing DMX512 "smart lighting" capabilities into their work

Potential Applications

This technology, if proven usable for spacecraft applications, will revolutionize how we do system architecture for lighting systems and allow spacecraft environmental/avionics systems to blend the lines between architectural lighting and digital indication.

Automation will also make the goal of producing an earthlike 24 hour circadian cycle possible at a system spacecraft level while also providing a means for the spacecraft to automatically control power usage by the lighting system.